

SENSOR ASSEMBLY FOR STRINGED MUSICAL INSTRUMENTS

CROSS-REFERENCE TO RELATED APPLICATION(S)

The present invention claims the priority date of
5 copending United States Provisional Patent Application Serial
Number 60/262,218, filed January 17, 2001.

BACKGROUND OF THE INVENTION

10 1. Field of the Invention

The present invention relates generally to musical
instruments and, more particularly, to a sensor assembly for
use with stringed musical instruments.

15 2. Description of the Related Art

Generally, stringed musical instruments such as
electric guitars have electromagnetic sensors or pick-ups for
sensing mechanical vibrations of the strings and converting
such into electrical signals. The electrical signals from the
20 electromagnetic sensors are amplified and modified and,
ultimately, reconverted into acoustical energy to produce
music and the like.

U.S. Patent Nos. 5,501,900 and 5,438,157, issued to
Lace, discloses an acoustic electromagnetic sensor assembly
25 and mounting assembly for a stringed musical instrument. In
that patent, the sensor assembly has a mounting assembly which

fits in a sound hole of the stringed musical instrument. These electromagnetic sensors have a high visual impact when mounted on a stringed musical instrument such as an acoustic guitar. Further, these electromagnetic sensors typically have
5 a tone and output that has a single value.

It is desirable to provide a sensor assembly that has less of a visual impact. It is also desirable to provide a sensor assembly with more variations in tone and output. Therefore, there is a need in the art to provide a sensor
10 assembly, which meets these desires.

SUMMARY OF THE INVENTION

It is, therefore, one object of the present invention to provide a sensor assembly for a stringed musical
15 instrument.

It is another object of the present invention to provide an electromagnetic sensor for an acoustic stringed musical instrument that has a low visual impact.

It is a further object of the present invention to
20 provide an electromagnetic sensor for an acoustic stringed musical instrument that provides flexibility in tone and output of the sensor.

To achieve the foregoing objects, the present invention is a sensor assembly for a stringed musical

instrument having a plurality of movable strings. The sensor assembly includes at least one blade adapted to be disposed adjacent the strings and at least one magnet disposed adjacent the at least one blade to generate a magnetic field through the at least one blade. The sensor assembly includes a primary winding disposed adjacent the at least one blade to create a primary current from a disruption in the magnetic field by the moveable strings. The primary current creates a primary electromagnetic flux. The sensor assembly also includes at least one secondary winding spaced from the primary winding and being magnetically coupled to the primary winding. The at least one secondary winding transforms the primary electromagnetic flux into a secondary current adapted to be passed out the stringed musical instrument.

One advantage of the present invention is that a new sensor assembly is provided for a stringed musical instrument. Another advantage of the present invention is that a sensor assembly is provided for a stringed musical instrument, which has low impact visually on the instrument or is virtually invisible on the instrument. A further advantage of the present invention is that the sensor assembly provides flexibility in the tone and output of the sensor. Yet a further advantage of the present invention is that the sensor assembly is quieter via making a primary winding humbucking.

Still a further advantage of the present invention is that the sensor assembly uses neodymium magnets to decrease the packaging size, making the assembly smaller, and more versatile in mounting. Another advantage of the present invention is that the sensor assembly has at least one blade to aesthetically blend into the neck of the stringed musical instrument such as a guitar. Yet another advantage of the present invention is that the sensor assembly has full humbucking primary and secondary windings. Still another advantage of the present invention is that the sensor assembly has greater sensitivity with a primary winding at the top of the blade. A further advantage of the present invention is that the sensor assembly is non-visually distracting and blends in with the end of the neck or can be in neck.

Other objects, features, and advantages of the present invention will be readily appreciated, as the same becomes better understood, after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a sensor assembly, according to the present invention, illustrated in operational relationship with a stringed musical instrument.

FIG. 2 is a side elevational view of the sensor assembly and stringed musical instrument of FIG. 1.

FIG. 3 is a perspective view of the sensor assembly of FIG. 1.

5 FIG. 4 is a side elevational view of the sensor assembly of FIG. 1.

FIG. 5 is a plan view of the sensor assembly of FIG. 1.

10 FIG. 6 is a front view of the sensor assembly of FIG. 1.

FIG. 7 is a schematic view of a single secondary winding for the sensor assembly of FIG. 1.

FIG. 8 is a schematic view of a dual secondary winding in parallel for the sensor assembly of FIG. 1.

15 FIG. 9 is a schematic view of a dual secondary winding with a potentiometer for the sensor assembly of FIG. 1.

FIG. 10 is a perspective view of another embodiment, according to the present invention, of the sensor assembly of
20 FIG. 1 illustrated in operational relationship with a stringed musical instrument.

FIG. 11 is a plan view of the sensor assembly of FIG. 10.

FIG. 12 is a front view of the sensor assembly of FIG. 10.

FIG. 13 is a plan view of yet another embodiment, according to the present invention, of the sensor assembly of FIG. 1 illustrated in operational relationship with a stringed musical instrument.

FIG. 14 is a partial perspective view of the sensor assembly and stringed musical instrument of FIG. 13 illustrated with the strings removed.

FIG. 15 is a perspective view of the sensor assembly of FIG. 13 illustrated with the secondary windings removed.

FIG. 16 is a plan view of the sensor assembly of FIG. 13.

FIG. 17 is an exploded perspective view of the sensor assembly of FIG. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring to the drawings and, in particular, to FIGS. 1 and 2, one embodiment of a sensor assembly 10, according to the present invention, is illustrated in operational relationship with a stringed musical instrument, such as a guitar, generally indicated at 12. The guitar 12 is of the acoustical type having a neck portion 14 with a fingerboard 15, a body portion 16, and a plurality of strings

18 extending along the neck and body portions 14 and 16, respectively. The sensor assembly 10 is disposed beneath the strings 18 and mounted to the body portion 16 adjacent to or in the fingerboard 15 in a manner to be described. Although
 5 the sensor assembly 10 is illustrated with a guitar 12, it should be appreciated by those skilled in the art that any suitable type of stringed musical instrument may be enhanced by the sensor assembly 10. It should further be appreciated that the sensor assembly 10 may be used with either an
 10 electric type of stringed musical instrument 12.

The sensor assembly 10 may include a case (not shown) extending longitudinally and having a general "U" shape cross-section. The case has a generally planar base wall and a pair of generally planar side walls substantially parallel
 15 to each other and connected by generally arcuate shaped corner walls to the base wall to form a longitudinal channel. Preferably, the longitudinal channel has a lateral width greater than a height thereof. The case is fabricated from a single piece of ferromagnetic material such as an iron-based
 20 steel. The case may be secured by suitable means such as fasteners (not shown) to the fingerboard 15 as illustrated in FIG. 2.

Referring to FIGS. 2 through 6, the sensor assembly 10 includes a primary winding 26 made from a conductive

material. Preferably, the primary winding 26 is made of a conductive material such as copper. The primary winding 26 is preferably a solid piece of copper made as a single layer stamping or multilaminate construction. It should be appreciated that the primary winding 26 may be made of any suitable conductive material.

The primary winding 26 has a configuration that acts as a one-turn receiver. In one embodiment, the primary winding 26 has a generally rectangular shape with a slot 27 extending therethrough. The primary winding 26 has a predetermined length. Preferably, the primary winding 26 extends to encompass all of the moveable strings 18. It should be appreciated that the primary winding 26 may be configured to have other suitable shapes other than the rectangular shape. It should also be appreciated that the primary winding 26 may be a plurality of windings.

The sensor assembly 10 also includes at least one, preferably a plurality of magnets 28 disposed adjacent the primary winding 26 to provide a magnetic flux field to the strings 18. The magnets 28 are secured to the interior surface of the case by suitable means such as an adhesive bonding agent. The magnets 28 are a permanent magnet strip and is made of a flexible permanent magnet material such as PLASTIFORM® which is commercially available from Arnold

Engineering, Marango, IL. The magnets 28 extend longitudinally and are generally rectangular in shape. It should be appreciated that the magnets 28 are orientated in a manner to be described.

5 . The sensor assembly 10 also includes at least one, preferably a plurality of secondary windings 30 adjacent to the primary winding 26. In one embodiment, the secondary windings 30 extend generally perpendicular to the primary winding 26. The secondary windings 30 are coils of a conductive wire such as
10 copper wrapped around core elements 32,34 to be described. It should be appreciated that the secondary windings 30 can be either single or multiple coils connected in series or parallel.

 The secondary windings 30 are susceptible to electromagnetic flux transferred by the core elements 32 to be
15 described from the primary winding 26. The secondary windings 30 transform the primary electromagnetic flux into a secondary current. More specifically, the primary winding 26 and the secondary windings 30 and the core elements 32,34 act together as a transformer which transforms the primary current into the
20 secondary current. The secondary current is passed through an output port (not shown) to electronics subsequent to the sensor assembly 10. Although the primary winding 26 is shown to be a separate circuit than that of the secondary windings 30, the secondary windings 30 may in an alternative embodiment (not

shown) be connected in series to the primary winding 26 at a common point to create an autotransformer. It should be appreciated that possible electronic components, which may be operatively connected to the output port include receivers, synthesizers, amplifiers, speakers, and the like.

The secondary windings 30 are shorter in length than the predetermined length of the primary winding 26. The secondary windings 30 include a first core element 32, which extends through one end of the secondary windings 30 and a second core element 34, which extends through the other end of the secondary windings 30. In one embodiment, the first and second core elements 32,34, which are "U" shaped in appearance, extend into the secondary windings 30 from each end and telescopingly engage. The core elements 32,34 are made from laminations of a high permeable magnetic material such as steel. It should be appreciated that the sensor assembly 10 may have a single secondary winding 30 as illustrated in FIG. 7 or multiple secondary windings 30 as illustrated in FIGS. 3 through 6 that can be combined in different ways to create a variety of tones. It should also be appreciated that the multiple secondary windings 30 may be configured in a dual parallel arrangement as illustrated in FIG. 8 or with a potentiometer 36 as illustrated in FIG. 9. It should further be appreciated that the use of multiple secondary windings 30 provides flexibility

in the tone and output of the sensor assembly 10. It should be still further appreciated that the multiple secondary windings 30 can be a variety of values and can be used with an elongated primary winding 26 to allow flexibility in the design and placement of the sensor assembly 10.

The sensor assembly 10 further includes a blade 40 extending through the slot 27 in the primary winding 26. The blade 40 acts as a core piece to conduct the magnetic field and to provide a flux connection to the strings 18. The blade 40 is fabricated from a ferromagnetic material such as cold rolled steel. The blade 40 is a thin plate made of steel or other such material that is susceptible to a magnetic field. The blade 40 includes a base end 42 and a distal end 44. The base end 42 is disposed adjacent the magnets 28 and may be fixedly secured to the magnets 28 via any suitable securing device, such as an adhesive epoxy. The distal end 44 is a sharp edge, which receives the movable strings 18 thereon. The distal end 44 is curvilinear allowing it to blend in with the curvature of the fingerboard 15 and apply equal flux on each of the movable strings 18 so that each of the movable strings 18 affects the magnetic field from the blade 40 equally. It should be appreciated by those skilled in the art that the curvilinear shape of the distal end 44 might vary depending on the type of stringed musical instrument 12 used.

It should also be appreciated by those skilled in the art that the distal end 44 may even be straight for such instruments as acoustic violins, banjos, ukuleles, and the like wherein the strings all are set in a single plane.

5 Referring to FIGS. 10 through 12, another embodiment, according to the present invention, of the sensor assembly 10 is shown. Like parts of the sensor assembly 10 have like reference numerals increased by one hundred (100). In this embodiment, the sensor assembly 110 includes a case or
10 cover 150 extending longitudinally and having a general "U" shape cross-section. The cover 150 has a generally planar base wall 152 and a pair of generally planar side walls 154 substantially parallel to each other and connected by generally arcuate shaped corner walls 156 to the base wall to
15 form a longitudinal channel 158. Preferably, the longitudinal channel 158 has a lateral width greater than a height thereof. The cover 150 has a flange 160 extending outwardly at each corner wall 156 and generally perpendicular thereto. The flange 160 has an aperture 162 extending therethrough to allow
20 a fastener (not shown) to extend through the aperture 162 and slot 127 of the primary winding 126 and secure the cover 150 to the body portion 16 of the stringed musical instrument 12. The cover 150 is fabricated from a single piece of material

such as plastic or an iron based steel and forms a cup to contain the magnets 128, primary winding 126, and blade 140.

The sensor assembly 110 also has a case 164 for the secondary windings 130. The case 164 is disposed about the secondary windings 130 and secured thereto by suitable means. The core piece 132 may have a projection 166 to extend through the slot 127 to secure the secondary winding 130 to the primary winding 126. It should also be appreciated that the primary winding 126 may have a portion disposed below a plane of a remainder thereof to which the secondary windings 130 are attached.

Referring to FIGS. 13 through 17, yet another embodiment, according to the present invention, of the sensor assembly 10 is shown. Like parts of the sensor assembly 10 have like reference numerals increased by two hundred (200). In this embodiment, the sensor assembly 210 includes a primary winding 226 having a configuration that acts as a one-turn receiver. In this embodiment, the primary winding 226 has a base 226a extending transversely to encompass all of the moveable strings 18. The primary winding 226 also has a first end 226b extending generally perpendicular to the base 226a and a second end 226c extending generally perpendicular to the base 226a. The second end 226c has a generally "J" shape for a function to be described. The primary winding 226 is made from

a non-ferrous, conductive material. Preferably, the primary winding 26 is made of a conductive material such as copper. It should be appreciated that the first end 226b and second end 226c do not contact each other and that the primary winding 226
5 is not a closed loop, but an open loop.

The sensor assembly 210 also includes at least one, preferably a plurality of magnets 228 disposed adjacent the primary winding 226 to provide a magnetic flux field to the strings 18. The magnets 228 are secured between and to a pair
10 of blades to be described by suitable means such as an adhesive bonding agent. The magnets 228 are made of a permanent magnet material such as Neodymium, which is commercially available. The magnets 228 are spaced longitudinally and are generally circular in shape. It should
15 be appreciated that the magnets 228 are orientated in a manner to be described. It should also be appreciated that the magnets 228 may be made of other types of magnetic material.

The sensor assembly 210 also includes at least one, preferably a plurality of secondary windings 230 adjacent to the
20 primary winding 226. In one embodiment, the secondary windings 230 extend generally perpendicular to the primary winding 226. The secondary windings 230 are coils of a conductive wire such as copper wrapped around core elements 232, 234.

The secondary windings 230 are susceptible to electromagnetic flux transferred by the core elements 232 from the primary winding 226. The secondary windings 230 transform the primary electromagnetic flux into a secondary current. More specifically, the primary winding 226 and the secondary windings 230 and the core elements 232,234 act together as a transformer which transforms the primary current into the secondary current. The secondary current is passed through an output port (not shown) to electronics subsequent to the sensor assembly 210. It should be appreciated that possible electronic components, which may be operatively connected to the output port include receivers, synthesizers, amplifiers, speakers, and the like.

The secondary windings 230 are shorter in length than the predetermined length of the primary winding 226. The secondary windings 230 include a first core element 232, which extends through one end of the secondary windings 230 and a second core element 234, which extends through the other end of the secondary windings 230. In one embodiment, the first and second core elements 232,234, which are "U" shaped in appearance, extend into the secondary windings 230 from each end and telescopingly engage. Each of the core elements 232,234 is made from a plurality of laminations, preferably four, of a high permeable magnetic material such as steel. It should be appreciated that the sensor assembly 210 has a pair of secondary

windings 230 that act as dual humbucking secondaries. It should also be appreciated that the secondary windings 230 may be spaced farther from the primary winding 226 as illustrated in FIG. 14.

5 The sensor assembly 210 further includes a plurality, preferably a pair, of blades 240 disposed on the sides of the primary winding 226 such that the primary winding 226 is disposed therebetween. The blades 240 act as a core piece to conduct the magnetic field and to provide a flux connection to the strings 18. The blades 240 are fabricated from a ferromagnetic material such as cold rolled steel. The blades 240 are a thin plate made of steel or other such material that is susceptible to a magnetic field. The blade 240 includes at least one, preferably a plurality of apertures 10 260 extending therethrough for a function to be described. One of the blades 240 is disposed adjacent the magnets 28 and the blade 240 may be fixedly secured to the magnets 28 via any suitable securing device, such as an adhesive epoxy. The other one of the blades 240 has an inner surface 261 that is 15 electrically insulated from the magnets 228. That blade 240 disposed on one side of the primary winding 226 and the other blade 240 is disposed on the other side of the primary winding 226 and the primary winding 226 and blades 240 are electrically secured together by suitable means such as 20

soldering at a plurality of locations 262. The blades 240 have a distal end 244 that is curvilinear allowing it to blend in with the curvature of the fingerboard 15 and apply equal flux on each of the movable strings 18 so that each of the

5 movable strings 18 affects the magnetic field from the blades 240 equally. It should be appreciated by those skilled in the art that the curvilinear shape of the distal end 244 might vary depending on the type of stringed musical instrument 12 used. It should also be appreciated by those skilled in the

10 art that the distal end 244 may even be straight for such instruments as acoustic violins, banjos, ukuleles, and the like wherein the strings all are set in a single plane. It should further be appreciated that one of the blades 240 is magnetic north and the other blade is magnetic south. It

15 should still further be appreciated that the sensor assembly 210 may be mounted to the end of the neck 14 by suitable means such as fasteners (not shown) extending through the apertures 260 in the blades 240 and into the neck 14.

The present invention has been described in an

20 illustrative manner. It is to be understood that the terminology, which has been used, is intended to be in the nature of words of description rather than of limitation.

Many modifications and variations of the present invention are possible in light of the above teachings.

Therefore, within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described.

100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000